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NONDESTRUCTIVE INSPECTION OF LONGITUDINAL STIFFENER BUTT WELDS --ETC(U)
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NONDESTRUCTIVE INSPECTION OF LONGITUDINAL STIFFENER BUTT WELDS IN COMMERCIAL VESSELS

SHIP STRUCTURE COMMITTEE

1980

SHIP STRUCTURE COMMITTEE

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Ship Structure Committee

An Interagency Advisory Committee
Dedicated to Improving the Structure of Ships

Address Correspondence to:

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APRIL 1980

SR-1249

For new merchant ship construction, nondestructive inspection of the hull, decks and bottom plating is normally required only for selected shell and deck plating butt welds. With the trend toward larger ships and lighter scantlings, the Ship Structure Committee became concerned that the weld inspection requirements might have to be extended to the longitudinal stiffeners of the vessel.

A project was undertaken to examine structural failure reports and evaluate if more inspection was needed and, if so, to recommend necessary procedures. This report addresses the subject. The survey did not discover significant failures of longitudinal stiffener butt welds and therefore does not recommend any additional testing or inspection.

Henry H. Bell
Rear Admiral, U.S. Coast Guard
Chairman, Ship Structure Committee

(19)

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16. Abstract

A study has been made of the butt welds which join together the sections of longitudinal stiffeners in longitudinal framed ships. From a review of Coast Guard casualty reports and a survey of major shipbuilders, it was determined that there is very little evidence of structural failure in service and, therefore, no need at this time to expand nondestructive inspection to include this type of weld joint.

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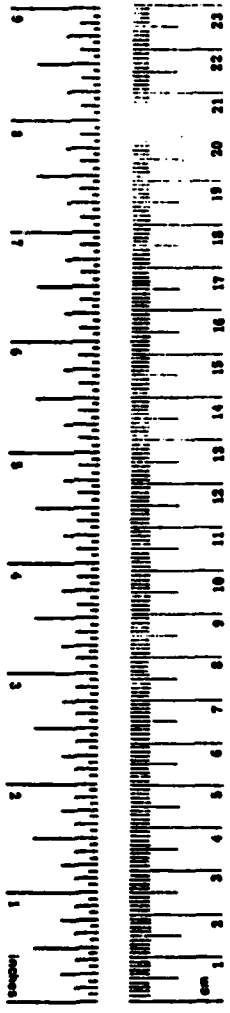
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

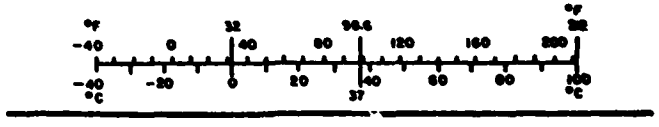
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

For new merchant ship construction, there are requirements for quality assurance for hull and deck plating butt welds[1]; however, there are no such requirements for the welds which join together the sections of longitudinal stiffeners. It has been suggested that there may be a need for quality assurance here also. The reasoning in favor of nondestructively inspecting these weld joints is that to be considered effective in resisting hull bending, longitudinals on shell, decks, longitudinal bulkheads, etc., must be continuous[2]. While the requirement for continuity strongly suggests a need for Nondestructive Testing (NDT), there are additional considerations.

Modern steel vessels contain literally miles of welds which bear load and for which a rationale can be constructed supporting a need for NDT; but to do NDT on all such welds would be prohibitively expensive. As a consequence, the builders of ships, the owners, and the regulatory agencies have devised schemes whereby what NDT is to be done will be concentrated on those weld joints which experience has proven to be subject to the most severe stresses, primarily the hull plating butt welds.

Any NDT applied to joints elsewhere would involve either some substitution of inspection locations or added cost of fabrication. Either of these alternatives would be a major consideration to the shipbuilding industry and changes in present procedure should not be initiated without technical facts supporting that position.

The Naval Surface Weapons Center contracted to research this subject and make recommendations. This report describes the results of that work.

OBJECTIVE AND SCOPE

The objective of this task has been to determine if there is a need for nondestructive inspection of the welds which join the sections of longitudinal stiffeners. This was to be done by reviewing available marine casualty reports and surveying the major shipbuilders to ascertain if the weld joints in question have a history of failure, and by consultation with naval architects to determine the load-bearing requirements for longitudinal stiffeners.

If it were determined that nondestructive testing should be done, then recommendations were to be made regarding methods, procedure, acceptance, criteria, etc. Such recommendations would reflect the current state-of-the-art of NDT.

LONDITUDINAL STIFFENERS

There are two general types of ship construction employing stiffeners: londitudinally framed and transversely framed. This study was limited to longitudinally framed ships and to four specific cross-sectional configurations: i.e., "L", "T", "H", and flat bar, Figure 1. Although the configurations differ, in each case continuity is achieved by a butt weld between sections. Without exception, these butt welds are specified for full penetration. The sections are ordinarily twenty feet or longer. Thickness may be as little as 1/4 inch, or as great as an inch or more.

While there may be cases where only one side of the weld is accessible, in most instances both faces of the weld are accessible.

CASUALTY REPORTS

It was determined that the U. S. Coast Guard does have a file of casualty reports. The United States Salvage Association, Inc. does not and the records kept by the American Bureau of Shipping are not suited to a search for specific structural member failure.

The U. S. Coast Guard maintains a record of structural failure casualties. Since 1963 a total of 897 cases have been categorized and incorporated into a computer program. Using the key words, "structural failure", "steel welds", "fractured plates and internals", and "fractured welds" only 88 possible cases were uncovered for use in this study.[3] A careful review of these 88 reports revealed that none of these cited a fracture of the type of weld joint pertinent to this study.

Through letter inquiry it was learned from the America Bureau of Shipping that they have no evidence of structural problems relating to butt welds in longitudinal stiffeners.

CONSIDERATIONS RELATING TO NAVAL ARCHITECTURE

Longitudinals are normally made continuous in order to assure their effectiveness in resisting bending of the hull girder and classification societies include them in calculating the hull girder section modulus. In regard to weld discontinuities, the naval architect assumes that the weld joint is at least as strong as the parent metal of the stiffeners. This assumption necessitates full penetration welding and does not allow for welding flaws except within the framework of an added safety factor. Containerships are a special case. Since there is relatively little deck, the strength ordinarily provided by that member is designed into large box girders on each side of the ship and quality assurance is especially important.

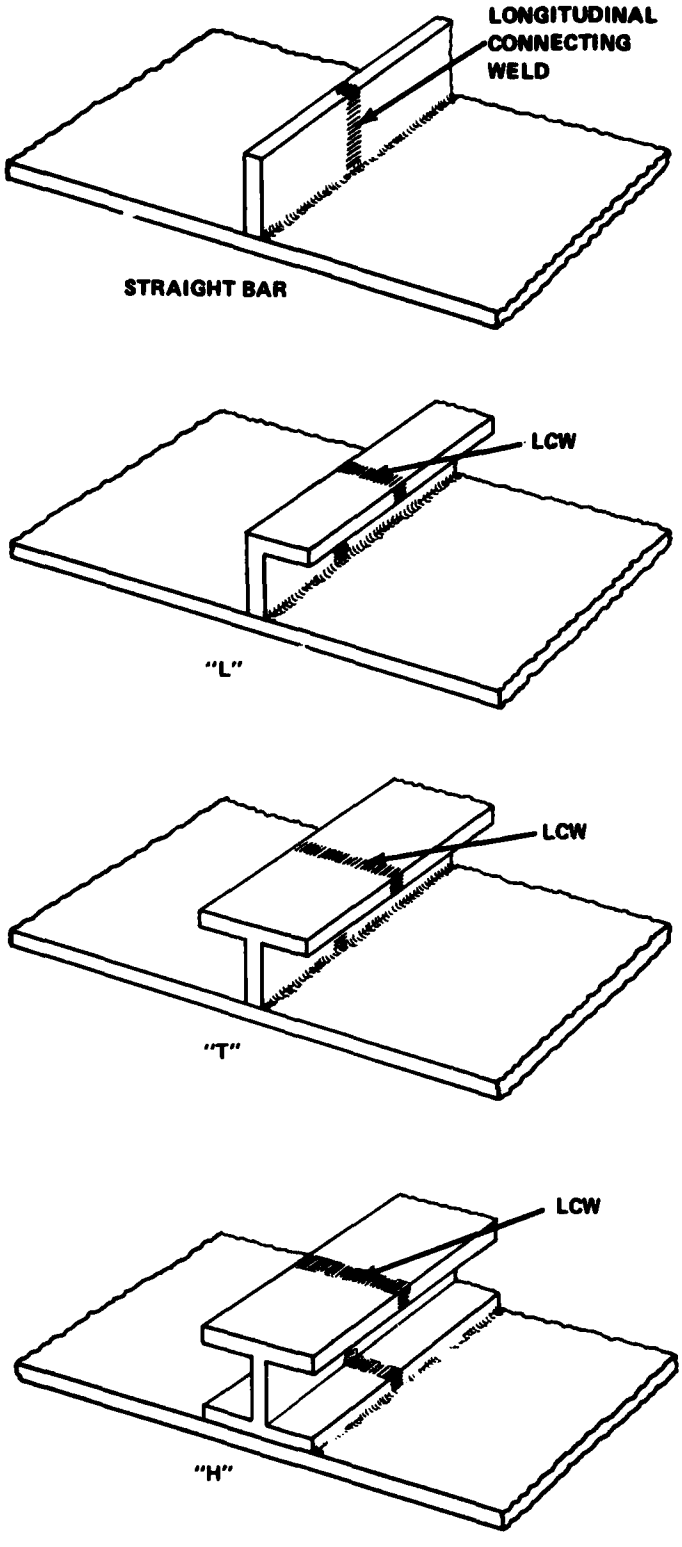

FIGURE 1 CROSS SECTIONAL CONFIGURATIONS OF TYPICAL LONGITUDINAL STIFFENERS

Certain other types of ships have a longitudinal girder incorporated into the deck which functions there as does the keel in the hull. These also are longitudinals with requirements for continuity.

A SURVEY OF MAJOR SHIPBUILDING FACILITIES

It was specifically requested that the major shipbuilders be contacted in regard to this task and pursuant to that request, a survey was conducted which included visits to five major shipbuilders. From this survey, it was learned that failure in service of these type joints is "very" infrequent and consequently very little NDT is done except for containerships. When NDT is done on the longitudinal joints, it is usually because such inspection has been requested by the owner. However, the shipbuilders do some NDT just to encourage and maintain good workmanship.

Since these are full penetration joints, radiography and ultrasonics are the methods used to determine interior integrity. Ultrasonics (UT) is most commonly used because of lower cost and ease of application.

Usually, the acceptance criteria is the same as that used when evaluating hull welds. In one case, the ultrasonic acceptance criteria was modified to permit "slightly" longer discontinuity length but with the signal amplitude criteria unchanged.

Direct costs would be unchanged if NDT of these joints were to be substituted for some other hull weld inspection. If, however, this type NDT were to be done in addition to the current amount of weld inspection, then there would be an increase in inspection costs at a rate equivalent to what is now charged per joint in hull weld NDT.

The box-girder type construction found in containerships is a special case and is extensively inspected primarily with UT. The procedure and acceptance criteria used is the same as that for butt welds in hull plating.

CONCLUSIONS AND RECOMMENDATIONS

Based upon the review of the Coast Guard Casualty Reports and the survey of the major shipbuilders, it is concluded that there is not at this time any serious problem regarding the welds which join together the sections of longitudinal stiffeners. Accordingly, it is recommended that the present practice be continued whereby the funds available for NDT are concentrated on those weld joints known to be subject to severe stress.

The containership is a special case and merits nondestructive testing of all butt welds in the box girder construction to provide assurance of proper weld quality. Present practice appears adequate.

It should be noted, however, that the longitudinal stiffeners are load-bearing members and that there is a technical requirement for continuity. If, in the future, evidence is found that these type joints are failing in service, then the preceding conclusions and rationale should be revised.

If future experience does produce a need for nondestructive testing of these weld joints, the procedure and acceptance criteria used on hull butt welds could be used.

REFERENCES

1. Rules for Building and Classing Steel Vessels, 1979 American Bureau of Shipping, 65 Broadway, New York, NY

2. Principles of Naval Architecture; Society of Naval Architects and Marine Engineers, 74 Trinity Place, New York, NY, Page 182.

3. Coding Instructions for Commercial Vessel Casualties (As amended FY 1976); U. S. Coast Guard, Washington, DC.

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